ROBL-CRG	**Experiment title:** **Scanning XRD Investigations of the gradient of martensite content in fatigued steel X6CrNiTi18.10**	**Experiment number**: 20_02_027
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Report:

Cyclic strains lead to material degradation known as fatigue damage and finally to failure of engineering components. However, in some meta-stable austenitic steels such cyclic loads are accompanied by strain-induced martensitic transformation. In order to investigate under which conditions the formation of martensite occurs, the martensite content in dependence on the radial (y-) and axial (x-) location was estimated by X-ray diffraction (XRD) at a length cut of a „hour glass“ sample (ASTM E606, Fig. 1). Due to this sample shape, different strain amplitudes were realised at different axial positions of one sample.

In order to use the structure data from literature, the wavelength of the Mo-Kα radiation (λ = 0.07107 nm) was applied. A mapping of the axial and radial martensite distribution were gained by scanning the sample through the fixed beam.

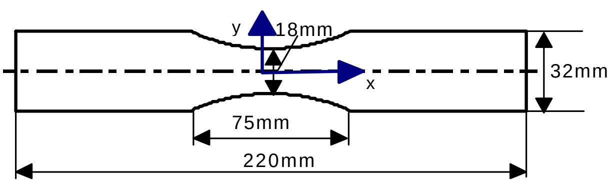

Fig. 1: Geometry of the hour glass sample

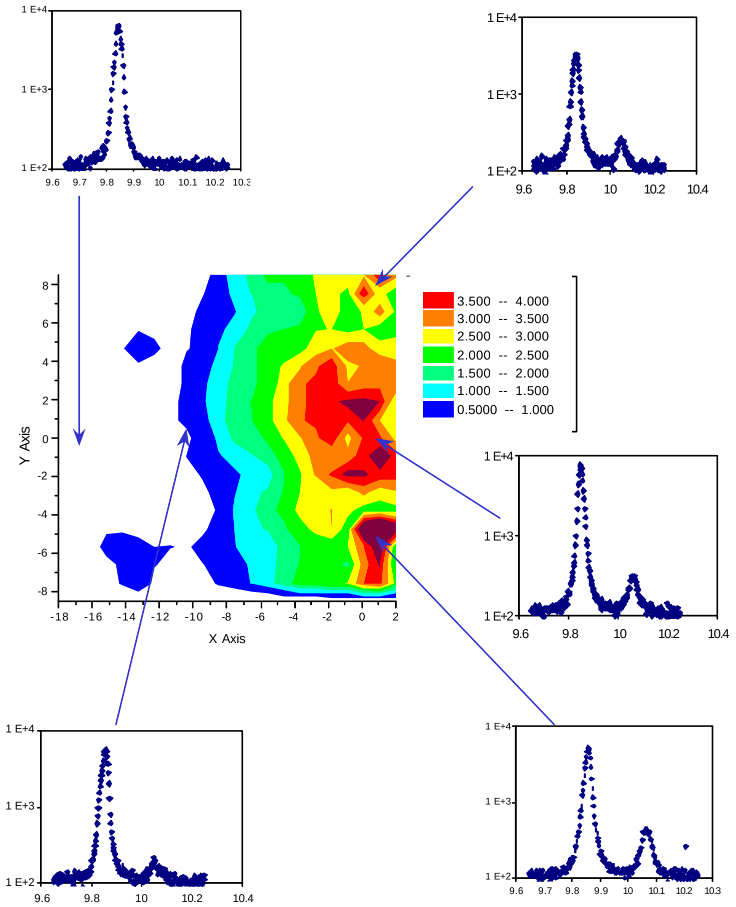

Fig. 2: Axial (x) and radial (y) mapping of martensite content depending on the sample location connected with typical diffraction patterns.

Due to the applied wave length and the beam cross section of 0.2 mm * 0.5 mm, a gauge volume of about 1 mm (axial) * 0.5 mm (radial) * 0.005 mm (in depth) was achieved.

For the estimation of the martensite content, the intensity of the {111} austenite and the {110} martensite peak were compared. Due to the small beam size, the very small beam divergence and relative large grain size of the austenite(diameter about 20 - 30 µm), the statistic condition for a polycrystal (number of grains seen by the beam $N_G \rightarrow \infty$, in reality $N_G > 1000$) is not completely fulfilled. As a consequence, the intensity values of the {111} austenite reflexion of different locations are in a large scattering band. The grain size of the martensite is small enough and their number high enough to fulfil this condition. Because the mentioned percentage of the martensite is very small the mean value of the austenite {111} intensity can be used for phase analysis. Using this mean value, the relative error is in order of magnitude of the martensite content (< 6 %).

Fig. 2 shows the axial and radial mapping of the martensite content. Some typical scattering pattern are included. At x-locations below -16 mm, corresponding to a strain amplitude of 2.25 mm/m, no martensite was found. At x = -10 mm martensite can be found at the whole sample diameter. This location correlates with a strain amplitude of 2.65 mm/m. At the smallest sample cross section the martensite is concentrated near the surface. Additionally, a broad area with a relative high martensite content was found in the middle of the sample (x = 0, y = 0). At the crack location (x = 1 mm, y = -8 .. -4 mm) the martensite content reaches maximum values.